ATTACHMENT A
Remarks

Claims 1, 5-30, and 35-52 are pending in the present application. By this amendment, Applicants have amended claim 30, cancelled claims 32-34 and added new claims 45-52. Applicants respectfully submit that the present application is in condition for allowance based on the discussion which follows.

Claims 32-34 were rejected under 35 U.S.C. § 112, first paragraph for failing to comply with the written description requirement alleging that the amendment to claim 32 in the Amendment filed with the RCE on February 22, 2006 constitutes new matter.

Applicants respectfully submit that the amendment to claim 32 in which the "(a) an ethylenic fluoropolymer" was corrected to "an ethylenic fluoromonomer", which by this amendment, claim 32 has been cancelled and its subject matter recited in claims 47 and 48, is fully supported in the specification as filed. Applicants respectfully direct the Examiner's attention to the specification as filed, page 13 lines 16- page 14 line 1 and in particular page 13, line 22 which recites "(a) fluoromonomer unit containing sulfonic acid functional groups." Thus, the prior amendment to claim 32 is fully supported in the specification as filed and therefore, Applicants respectfully submit that claims 47 and 48 fully comply with 35 U.S.C. § 112, first paragraph.

Further, claims 32-34 were rejected under 35 U.S.C. § 112, second paragraph alleging that the claims are ambiguous with regard to where one block, for example segment A, ends, and the next block, for example segment B, begins. In order to more clearly recite Applicants' invention and to leave no ambiguity as to where one block ends and another block begins, Applicants have cancelled claims 32-34 and added new claims 44-52 with claims 47 and 48 corresponding to the subject matter of now

cancelled claim 32, claims 49 and 50 corresponding to cancelled claim 33 and claims 51 and 52 corresponding to cancelled claim 34. In addition, by this amendment, Applicants have amended claim 30 with subject matter support being found in the specification as filed on page 10, lines 21-22 and page 12, lines 5-10. Further, Applicants have added claims 45 and 46 with subject matter support being found in the specification as filed on page 23 lines 2-4. Therefore, the claim amendments do not constitute new matter.

Furthermore, Applicants respectfully submit that the amended and added claims fully comply with 35 U.S.C. § 112, second paragraph. For example, claims 47 and 48 corresponding to the subject matter previously recited in now cancelled claim 32 further clarifies where segment A ends and segment B begins. For example, claim 47, dependent from claim 45, includes the limitation of segment B's molecular weight. If segment A includes a portion composed of monomer (b), the molecular weight of the portion is therefore smaller than segment B. Accordingly, segment A does not include segment B and therefore, there is no ambiguity as to where segment A ends and where segment B begins.

Claim 30, 32-36 and 38-40 were rejected under 35 U.S.C. § 102(e) as being anticipated by Cisar (U.S. 6,492,431) and claims 30-36 and 38-40 were rejected under 35 U.S.C. § 102(b) as being anticipated by Cisar (U.S. 5,635,039). Contrary to the Examiner's allegation both Cisar references fail to teach or suggest the claimed multi-segment fluoropolymer that comprises a block co-polymer and/or a graft co-polymer comprising segment A combined with segment B as claimed. By this amendment, Applicants have amended claim 30 to further clarify what would be readily understood

by one of ordinary skill in the art, with regard to a multi-segmented fluoropolymer comprising a block co-polymer and/or graft co-polymer having segment A and a segment B, namely that segment A is combined with segment B, thus forming a bond between segments in accordance with what would be understood by one of ordinary skill in the art as being a multi-segmented fluoropolymer.

Furthermore, evidence that one of ordinary skill in the art would understand that a multi-segmented fluoropolymer comprising a block co-polymer comprising a segment A and a segment B would have the segments or blocks bonded to one another to form a fluoropolymer, is provided herewith as a printout from the website Wikipedia.org which clearly shows that a block co-polymer and a graft co-polymer comprise segments A and B are bonded to one another (see page 1 of the Wikipedia reference).

Moreover, the present specification as filed, fully discloses that segment A is combined with segment B to form a chemical bond therebetween citing that a variety of processes are known to combine segment A with segment B to form blocks or grafts to obtain a multi-segmented fluoropolymer (see specification page 11, lines 4-20). Furthermore, the specification clearly distinguishes the combination of segment A with segment B to form a multi-segmented fluoropolymer with a mere blending of fluoropolymer segments (see specification page 11, line 21- page 12, line 4).

Again, it must be emphasized that one of ordinary skill in the art would readily understand that a multi-segmented polymer comprising segments in the form of blocks or grafts would be combined by forming chemical bonds therebetween and not merely having segment A blended with segment B (see specification page 12, lines 5 – 20).

Cisar '039 and '431 are specifically directed to a blended polymer which may comprise one or more fluoropolymers blended to form a membrane (e.g., Cisar '431, column 7, lines 16-29). The Cisar references make it clear that its material may contain portions which may have exclusively one polymer or another which it referred to as "blocks". However, it is clear from the Cisar disclosures that no bond is formed between individual "blocks" of polymers adjacent to one another in its blended polymer mixture. Thus, Cisar fails to teach or suggest creating a multi-segmented fluoropolymer comprising blocks or grafts. To the contrary, Cisar clearly teaches forming discrete polymer "blocks" (Cisar '431, column 7, lines 20-30). Further, Cisar '431 clearly teaches that in column 8, lines 30-44, two polymers namely PTFE and NAFION are blended to produce a membrane. However, the mixture in no way forms a multi-segmented fluoropolymer comprising blocks as claimed as one of ordinary skill in the art would understand a multi-segmented fluoropolymer to be.

Further, although Cisar '431 teaches how the individual polymers are formed from monomers to form its "blocks" of individual polymers, both Cisar references are completely silent with regard to forming any bond between its individual "blocks".

Based on the foregoing, Applicants respectfully submit that the Cisar references fail to teach or suggest the present invention, as a blended composition, as taught by the Cisar references, does not in any way anticipate or make obvious a multi-segmented fluoropolymer comprising a block copolymer and/or graft copolymer comprising a segment A combined with a segment B as claimed.

In view of the foregoing, Applicants respectfully submit that the present application is in condition for allowance.

END REMARKS

Heteropolymer

From Wikipedia, the free encyclopedia

A **heteropolymer**, also called a **copolymer**, is a polymer formed when two (or more) different types of monomer are linked in the same polymer chain, as opposed to a homopolymer where only one monomer is used. If exactly three monomers are used, it is called a **terpolymer**.

The assembly of the monomers in the copolymers can be head-to-tail, head-to-head, or tail-to-tail.

Block Copolymers

A special type of copolymer is called a "block copolymer". Block copolymers are made up of blocks of different polymerized monomers. For example, PS-b-PMMA is short for polystyrene-b-poly(methyl methacrylate) and is made by first polymerizing styrene, and then subsequently polymerizing MMA. This polymer is a "diblock copolymer" because it contains two different chemical blocks. You can also make triblocks, tetrablocks, pentablocks, etc. Diblock copolymers are made using "living polymerization" techniques, such as atom transfer free radical polymerization (ATRP), reversible addition fragmentation chain transfer (RAFT), living cationic or living anionic polymerizations.

Block copolymers are interesting because they can "microphase separate" to form periodic nanostructures.

Microphase separation is a situation similar to that of oil and water. Oil and water don't mix together- they *macro*phase separate. If you have an "oil-like" first block and a "water-like" second block, the block copolymers undergo *micro*phase separation. The blocks want to get as far from each other as possible, but they are covalently bonded, so they're not going to get very far. In "microphase separation" the "oil" and "water" blocks form nanometer-sized structures. These structures can look like spheres of PMMA in a matrix of PS or vice versa, or they could be stripes (often called lamellae in the technical literature) or cylinders. The nanoscale structures created from block copolymers could potentially be used for creating devices for use in computer memory, nanoscale-templating and nanoscale separations.

In official terms, polymer scientists wouldn't use "oil-like" and "water-like" to describe the polymer blocks' interactions. Polymer scientists use thermodynamics to describe how the different blocks interact. The "interaction parameter", also called "chi" gives an indication of how different, chemically, the two blocks are and whether or not they will microphase separate. If the product of chi and the molecular weight is large (greater than 10.5), the blocks will microphase separate. If the product of chi and the molecular weight is too small (less than 10.5), the different blocks are able to mix.

Types of copolymers

Since a copolymer consists of at least two types of repeating units (not structural units), copolymers can be classified based on how these units are arranged along the chain. These include

- Random copolymer: -A-A-B-B-A-A-A-B-A-A-B-B-A-B-A-A-A-B-A-A-A-B-B-
- Alternating copolymer: -A-B-A-B-A-B-A-B-A-B-, or $-(-A-B-)_n-$
- Block copolymer: -A-A-A-A-A-A-A-B-B-B-B-B-B-B-A-A-A-A-A-A-A-B-B-...
- Graft copolymer:

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-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-
              |
              B-B-B-B-B-B-B
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- Star copolymers
- Brush copolymers

See also

- Copolymers section of Polymer article
- Copolymerization

Retrieved from "http://en.wikipedia.org/wiki/Heteropolymer"

Categories: Polymers | Copolymers

Copolymerization

From Wikipedia, the free encyclopedia

In chemistry, **copolymerization** is the process of using more than one monomer to produce a copolymer, which will possess properties different to the homopolymer of either monomer. The resulting product may be a random copolymer, an alternating copolymer, or a block copolymer. In the copolymerization between two monomers, M_1 and M_2, the following reactions may occur:

~~M_1^* + M_1 --> ~~$M_1M_1^*$ (rate constant = k_{11})
~~M_1^* + M_2 --> ~~$M_1M_2^*$ (rate constant = k_{12})
~~M_2^* + M_1 --> ~~$M_2M_1^*$ (rate constant = k_{21})
~~M_2^* + M_2 --> ~~$M_2M_2^*$ (rate constant = k_{22})

Contents

Copolymerization Equation

The Mayo–Lewis equation[1] (also called the copolymerization equation) gives the molar ratios of the two monomers in the resulting copolymer as:

$$\frac{d[M_1]}{d[M_2]} = \frac{[M_1]\left(r_1[M_1] + [M_2]\right)}{[M_2]\left([M_1] + r_2[M_2]\right)}$$

where r_1 and r_2 are the reactivity ratios of the individual monomers and $r_1 = k_{11}/k_{12}$ & $r_2 = k_{22}/k_{21}$, i.e. r = the rate of reaction with another monomer of itself / the rate of reaction with a different monomer. r is also called the copolymerization parameter.

k_{11} and k_{22} are the rate constants for the homopolymerization of the two monomers. k_{12} and k_{21} are the rate constants for the reaction between the two different monomers.

In another form:

$$F_1 = 1 - F_2 = \frac{r_1 f_1^2 + f_1 f_2}{r_1 f_1^2 + 2 f_1 f_2 + r_2 f_2^2}$$

where F_1, F_2 are the mole fractions of monomers M_1, M_2 in copolymer:

$F_1 = 1 - F_2 = d[M_1]/(d[M_1]+d[M_2])$

and f_1, f_2 are the mole fractions of monomers M_1, M_2 in the feed:

$f_1 = 1 - f_2 = M_1/(M_1 + M_2)$

When the copolymer composition has the same composition as the feed, this composition is called the *azeotrope*.

Effect of Reactivity Ratios

- Homopolymer: favored when $r = \infty$

  -A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A-A- ($r_1 = \infty$)
  -B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B-B- ($r_2 = \infty$)

- Random copolymer (or statistical copolymer): favored when r_1, r_2 close to 1.

  -A-A-B-B-A-A-A-B-A-A-B-B-A-B-A-A-A-B-A-A-A-B-B-

- Alternating copolymer: favored when r_1, r_2 close to zero.

  -A-B-A-B-A-B-A-B-A-B-A-B-A-B-, or $-(\text{-A-B-})_n-$

- Block copolymer: favored when $r_1 > 1$ $r_2 > 1$

  -A-A-A-A-A-A-A-B-B-B-B-B-B-B-A-A-A-A-A-A-A-B-B-...

Examples

acrylonitrile butadiene styrene (ABS) plastic, styrene-butadiene-styrene (SBS), styrene-isoprene-styrene (SIS), P(VDF-TrFE).

External links

- http://www.chem.rochester.edu/~chem421/copoly.htm

Further reading

- Odian, G. *Principles of Polymerization*, 4th Ed., Wiley-Interscience, Hoboken, NJ **2004**, Ch. 6. ISBN 0-47-127400-3

References

1. ^ Mayo, F. R., and Lewis, F. M., *J. Am. Chem. Soc.*, **66**, 1594 (1944). DOI:10.1021/ja01237a052 (http://dx.doi.org/10.1021/ja01237a052)